RESEARCH IDEAS AND CONSIDERATIONS

(Based on **A User's Guide to the Brain**, *TIME*, January 29, 2007.)

Compiled March 1, 2007, by Shirley Bliley, Professional Division Director

The New Map of the Brain – We need some researchers with access to fMRI technology.

The Mystery of Consciousness – It is possible to learn to control one's heart rate. Unconscious functions are not as "unconscious" as scientists think. Survival of consciousness: *Life Before Life* by Jim Tucker, UVA researcher. Physiological triggers for OBEs: there has to be some physiological component but that is not necessarily all. Reality is whatever we focus upon *[the "invisible" gorilla exercise?]*. Consciousness flips/shifts from one focus to another *[phasing?]*. *Researchers are evaluating consciousness through visual stimuli. They seem to have skipped auditory stimuli.** " . . . few scientists doubt that they will locate consciousness in the activity of the brain." One researcher's opinion: "The biology of consciousness offers a sounder basis for morality than the unprovable dogma of an immortal soul."

* Comments and italics added. How about research on controlling or modulating autonomic functions?

How the Brain Rewires Itself – Thought can alter the physical structure of the brain. This ability is especially noticeable in the case of stroke, adaptation to blindness, and loss of a limb or limbs. This principle underlies the success of cognitive behavioral therapy (CBT) in dealing with obsessive-compulsive disorder (OCD). Mindfulness meditation affects OCD in a similar way by decreasing activity in the orbital frontal cortex. When the anti-depressive effects of CBT and medication were compared, however, CBT muted overactivity in the frontal cortex and raised activity in the hippocampus of the limbic system. Paroextine raised activity in the frontal cortex and depressed activity in the hippocampus. More activity in the left prefrontal cortex than in the right correlates with a higher contentment baseline. Buddhist monks adept at the generation of pure compassion were compared with undergraduate students who received a crash course in meditation. fMRI scans showed the adepts had greater activity in brain networks linked to empathy and maternal love—activity in the left prefrontal swamped activity in the right prefrontal (associated with negative moods)—the undergraduates showed no such changes. It appears that the positive state can be trained.

We do not have any formal research with the *Stroke Recovery Series* and precious little in the way of anecdotal reporting. Also, callers or participants asked me about Hemi-Sync for OCD more than once in 2006. Investigation of ways to use Hemi-Sync to promote the state of pure compassion could also be productive.

Six Lessons for Handling Stress – 1. There is a biological need to periodically disengage. Recent research, however, indicates that the primary triggers of job stress are unfairness in the workplace, silence about the reasons behind decisions, and being asked to act in conflict with one's personal ethics. 2. Too much or too little of the stress hormone cortisol in one's bloodstream are equally bad. 3. A shallow cortisol blip in the morning followed by a low, flattened level throughout the day is characteristic of Holocaust survivors, rape victims, and soldiers with PTSD. 4. Stress accelerates aging by shortening the telomeres on the ends of chromosomes faster. 5. People with low self-esteem are more vulnerable to stress. They also tend to have smaller hippocampi, the brain area that helps form new memories and retrieve old ones. If cortisol stays up for long periods of time, the body just readjusts the "normal" level. 6. When what used to work doesn't anymore and too many rules change at once, reasoning ability takes a

hit. The individual "freezes" and becomes unable to see options when confronted with unrelieved stress. A blunted cortisol level can persist for years.

Research building on Giampapa's n = 1 study of charges in his hormone levels—testosterone, cortisol, melatonin, and DHEA—during *LIFELINE* would be of value. See records in file.

Time Travel in the Brain – When parts of the brain are engaged in cognitive tasks, other areas go dark. The "dark" network comprises regions in the frontal, parietal, and temporal lobes. When someone is lying quietly in an MRI machine, that network lights up. We seem to be traveling backward and forward in time and milking our experiences for maximum learning. Traveling backward buys us many trials for the price of one; traveling forward—simulating future courses of action and likely consequences—enables humans to learn from mistakes without making them. Neuroscientists call dark network activity the brain's default mode: humans spend more of their time away from the present than in it.

What if Hemi-Sync affects the "default mode?" Is there some way to use this information to craft more effective learning enhancement exercises?

What the Mouse Brain Tells Us – Genes responsible for building the mouse and human brains are 90% identical. The Allen Brain Atlas (ABA) launched in fall 2006 is a Web-based, public-access database of all 20,000 or so genes expressed in the mouse brain. * Its molecular-level data is a resource for understanding both the healthy and diseased brain. The database is a fast way home in on genes implicated in human neurological disorders.

* The ABA could be a good resource.

What do Babies Know? – Developmental psychologist Jean Piaget concluded that infants younger than 9 months have no innate knowledge of how the world works or any sense of "object permanence." Researchers at Babylab, University of Manchester, UK, generally agree. Babies do have enough innate knowledge to recognize when something is different or "wrong." A baby's fascination with physically impossible events simply reflects a response to novel stimuli. The brain's visual buffer continues to represent objects after they've been removed. Novel and unexpected events create a mismatch between what's in the buffer and the new information. Learning seems to be the laborious business of resolving mismatches.

What occurs in a baby's brain when it successfully resolves a mismatch? How can that process be facilitated?

Who Should Read Your Mind? – Subjects shown photos of unfamiliar white and black faces, while their brains were scanned with fMRI machines, showed higher arousal in the amygdala—a brain area that corresponds with emotional arousal. The brain activity matched up with the results of psychological tests designed to measure unconscious racism. Being able to "define" racism would raise serious ethical questions about the use of such technology. Such advances in brain science have led to the rise of a new field: neuroethics. Although polygraphs are considered unreliable, the high-tech aura of brain scans may inspire more faith than is warranted. Do we have a right to brain privacy? Americans can't currently be compelled to give a DNA sample or submit to an MRI or brainscan without consent or a court order. There is interest within the intelligence community. In September 2006, ethicists and policymakers attending a Neuroethics Society sponsored symposium at Tufts University debated "potential benefits and threats to individual liberty of brain imaging and stimulation during intelligence gathering." The prospect of using brain scans to measure compatibility, truthfulness, or preferences has led some companies to formulate comprehensive ethics policies. **How To Change A Personality** (sidebar) – Deep Brain

Stimulation (DBS) for Parkinson's, psychoactive drugs, and off-label uses for the narcolepsy drug, modafinil, can also be tools for modulating and modifying the personality. But what about those who need but can't afford the new cognitive technologies or those who may be forced to submit to them? One researcher imagines a "neuro-correctional system" that could transform criminals into noncriminals.

A noninvasive intervention for modulating aggressive impulses would be quite a discovery.

The Flavor of Memories – Memories of dramatic, traumatic events illustrate two recent and crucial discoveries about how human memory works. First, despite movie-like clarity, each time a memory is retrieved and re-stored, it is subtly altered—overwritten like an edited electronic document. Second, memory and emotion are intimately linked biochemically through stress hormones like adrenaline and cortisol, which help to create stronger memories. In an emotion-charged situation, these two hormones signal the amygdala, which responds by releasing norepinephrine. Norepinephrine activates the autonomic nervous system and signals the brain to carefully record that next few minutes. Amygdala activity was predictive of the strength of the memories. [Anomalous case; a woman who remembers everything.] Given the hormone connection, there is no doubt that memory can be enhanced. Giving someone a shot of adrenaline, however, drives up the heart rate and some memory enhancing drugs are addictive. Researcher Roger Pitman believes that post-traumatic stress disorder (PTSD) results from brain chemicals reinforcing themselves in a vicious circle. Of patients admitted to ERs, those who present with the highest heart rates are the most likely to develop PTSD. And PTSD rates are higher in quadriplegics than in paraplegics. The former condition severs the link between the brain and the adrenals. Pitman has done experiments with ER trauma patients: some received propranolol, which interferes with adrenaline uptake. Others got placebos. All recorded accounts of their traumas. When they heard the tapes eight months later, 8 of fourteen placebo patients exhibited signs of PTSD. None of those who'd received propranolol did. A third year of a much larger trial is underway and the President's Council on Bioethics has questioned its propriety. A stuffy of at least 120 soldiers returning from Iraq is examining whether a compound called D-cycloserine can help the mind from new, less emotional associations with trauma. Its action is consistent with talk therapy, especially CBT. With the drug, patients realize noticeable benefits in far fewer sessions.

Once again, a noninvasive way of enhancing memory would pay big dividends. An intervention to effectively defuse PTSD symptoms would quickly become a growth industry.

Da, Da, Da, Da, Da – Research is being conducted to determine if areas of one's grey matter respond in the same way to the emotional contours of another's speech as they do when we ourselves are speaking. Neurons in the pre-motor cortex of macaques activate when they grasp a piece of food. The same neurons "buzz" when they watch researchers pick up food, as if they are mentally mirroring the action. Brain scans have now indirectly confirmed the presence of similar neurological activity in humans. Evidence suggests that the mechanism of mirror neurons may be the foundation of our empathic response. Their reflexive and involuntary activity may encode not just movements but also the meaning behind them. Some scientists see the mirror-neuron system as the biological foundation of language: language may trace its roots to hand gestures and facial expressions that became more complex over time. Macaques have mirror neurons in the parietal and premotor cortexes. In humans neurons with mirror properties may be more widely distributed, as in the somatosensory cortex that responds to skin sensations. Static images in photos, paintings, and sculptures can also evoke powerful emotional resonances. Mirroring may be the general mechanism for grasping the feelings of others and sharing their moods. Cues can be **auditory** as well as visual. Prosody—the melodic component of human speech—conveys information about shifting emotional states. Mirror neurons in the motor and sensory systems are special due to the web of connections that link them to limbic centers that process visceral and emotional reactions. Those connections are vastly expanded through experience. Individuals also vary widely in their capacity to

resonate with the emotional state of others. Subjects with high empathy scores exhibit stronger mirror scores to facial expressions. Autistic children, however, showed depressed activity in their pre-motor cortex while imitating or observing facial expressions. The more severe the autism, the more depressed the activity.

Does Hemi-Sync stimulate the pre-motor cortex? Berenice Luque has obtained some dramatic results by adding it to therapy regimens for autistic children.

Marketing to your mind – Brain imaging can be used to gain insight into the mechanisms behind people's decisions. Big Business plowed $8 billion in 2006 into market research in an attempt to predict and sway how citizens spend their money. One researcher performed his version of the Pepsi Challenge inside an fMRI machine in 2004. After a blind taste of both Coke and Pepsi, subjects were placed inside the scanner. Reward areas of the brain activated and preferences were almost evenly split. The tests were repeated and subjects were told what they were drinking. Three out of four preferred Coke and both reward and memory regions of the brain were activated. One researcher believes that "anticipatory emotions" are already priming the decision-making process before the cognitive areas of the brain are activated. The match between the value of a product, and its price triggers an anticipation of pleasure or pain. Viewing preferred products activated the nucleus accumbens, a brain region involved in anticipating pleasant outcomes. If the price was too high, activity increased in the insula, which is involved in anticipating pain. The brain pares down the decision-making process by taking advantage of previous experiences and stored information. Factors like trust, altruism, and gratitude for a favor also modify steps in decision making.

Does the DVD in the brochure have Hemi-Sync? Maybe there's a way to use words, images and Hemi-Sync to encourage viewers to attend programs and buy CDs.

The Power of Hope – An orthopedic surgeon treated a patient for hip and pelvic fractures caused by lung cancer that had also metastasized to the brain. As cancer replaced brain tissue, the patient sank into a non-responsive coma. To his wife's question of where her husband was, the surgeon replied that he didn't know "where he was, but [he] was pretty sure where he was going." The next day, the surgeon visited the now empty room and encountered an old Irish nurse who was caring for the patient when he died. She announced that he had "awakened," spoken lucidly, and touched his family for about five minutes before sinking back into a coma and dying an hour later. His wife later confirmed that event. The surgeon concluded that the patient's mind "weightless, invisible, maybe even timeless" had forced its way through "a broken brain." Somehow the mind is "smaller" than the brain's gross anatomy and "bigger" than the brain's physiology. This surgeon says that instances like "David's goodbye"make it impossible for him to be a materialist.

Consciousness really isn't in the brain after all. ☺

How We Make Life-and-Death Decisions – Philosopher David Hume emphasized that humans like to think their views of right and wrong are rational but ultimately they are grounded in emotion. There are intriguing responses to the "trolley problem," in which one person's life could be sacrificed to save five people. If it's possible to reroute the trolley by pulling a lever, the subject is likely to choose that option. If the subject must actively push someone onto the track to block the trolley, an emotional aversion may prevail. Up-close-and-personal the emotions usually win; if they lose, it's only after a tough wrestling match. While pondering a moral dilemma, brain regions linked to abstract reasoning and cognitive control light up. This utilitarian path weakens in someone who refuses to kill one innocent to save many. An evolved aversion to the killing of an innocent might be especially sensitive to visions of direct physical

assault, a frequent occurrence in ancient hunter-gatherer societies. *Maybe we should examine our moral intuitions and ponder whether survival of the fittest logic even merits respect.* *

*Worthy of careful consideration. Most of our participants probably have some interest in pondering ethical and esoteric issues. How could Hemi-Sync support that interest?